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TSUNAMI NEWSLETTER

IOC

ITIC

TSUNAMI NEWSLETTER - JANUARY 1995

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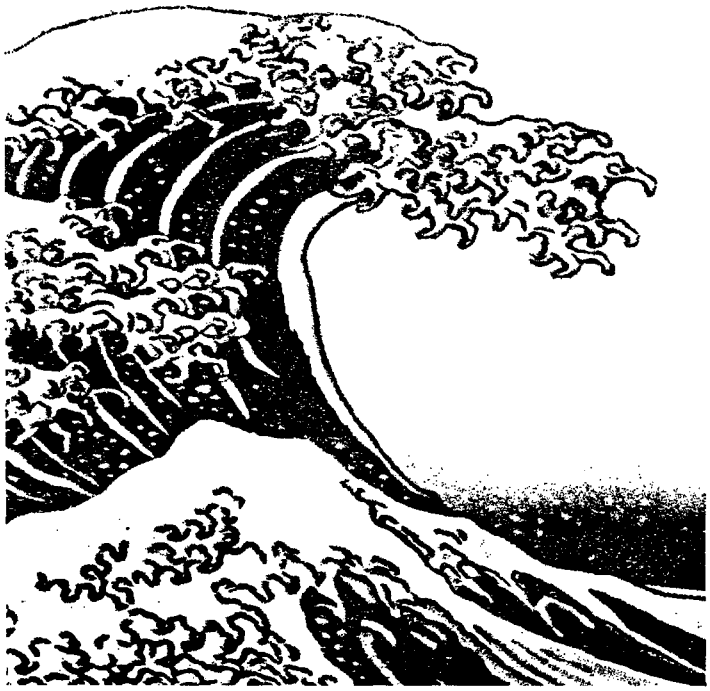
The TSUNAMI NEWSLETTER is published semi-annually by the International Tsunami Information Center (ITIC) to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

The ITIC is maintained by the U.S. National Oceanic & Atmospheric Administration (NOAA) for the Intergovernmental Oceanographic Commission (IOC). The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.



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COSTA RICA
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NICARAGUA
PERU
PHILIPPINES
REPUBLIC OF KOREA
SINGAPORE
THAILAND
UNITED KINGDOM (HONG KONG)
UNITED STATES OF AMERICA
WESTERN SAMOA

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18 American Water Resources Association Summer Symposium, Honolulu
18 International Workshop on Tsunami Measurements
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NEWS EVENTS

Bulletin! Major Earthquake Hits Japan on December 28th

At press time and as 1994 drew to a close, a major earthquake in the Pacific Ocean off Japan's main island of Honshu generated a non-destructive tsunami. The Ms 7.5 earthquake caused, however, considerable damage to property with at least two associated fatalities. The year 1994 has seen more tsunamis, many of them locally destructive, than in any year of the recent past (see related articles, News Events).

The earthquake's epicenter, about 90 nautical miles off the Sanriku coast, was located very near to the source area of the great 1896 and 1933 earthquakes and subsequent tsunamis that impacted the Sanriku coastline. This recent event was recorded by tide gauges in Japan with a maximum amplitude of 55 cm in Miyako. The Japan Meteorological Agency (JMA) also reported tsunami wave amplitudes at the following locations (*preliminary data*, one-half peak to trough):

Hachinohe	44 cm
Urakawa	24 cm
Ofunato	27 cm
Ayukawa	53 cm
Kushiro	18 cm
Hanasaki	25 cm
Hakodate	18 cm

The earthquake caused severe localized damage to the transportation infrastructure (rail lines and roadways) as well as public and private buildings. JMA initially issued a tsunami warning for the area but was subsequently canceled when no damaging wave activity was reported.

Earthquake and Tsunami Report, July through December 1994

The high level of worldwide seismic activity that was reported during the first six months of this year diminished somewhat in frequency during the last six months but not without generating a number of locally destructive tsunamis, one of which was recorded in many areas of the Pacific Basin. Four tsunamis were reported, three of which were locally destructive. A severe earthquake of moment magnitude 8.2 (USGS/NEIC), one of the largest this year, occurred in the northwest Pacific near the Kuril Islands on October 4. A locally destructive tsunami was generated that impacted the coastlines of Russia and Japan and was recorded as far away as Tahiti and Chile. Preliminary field survey results indicate a runup of 9+ meters was measured on Shikotan Island, Russia. A major aftershock of Richter magnitude 7.0 occurred on October 9, and generated a small tsunami that was recorded by tide gauges in Japan.

In the central western Pacific two volcanoes on the perimeter of Rabaul, Papua New Guinea Harbor erupted over a three week period in September and October covering the surrounding area with ash and pumice. Five fatalities were officially counted with significant damage to buildings and homes widespread in the Rabaul Town area. There was concern, initially, a local tsunami would be generated by the earthquake and explosive eruptive activity associated with the two volcanoes, Tavurvur and Vulcan. Much to the relief of the local population, no destructive tsunami was generated. The volcanic-related destruction, however, was significant with a long period of recovery and rehabilitation expected.

An Ms 6.8 earthquake occurred south of Halmahera Island, Indonesia, in the Obi Strait generating a tsunami that caused localized damage on Obi Island on October 9, 1994 (DHA Geneva). This report has not yet been confirmed by the Indonesian Meteorological and Geophysical Agency.

The Philippine island of Mindoro, about 100 kilometers south of Manila, was rocked by a large Ms 7.1 event during the early morning hours (local time) of November 15. The earthquake, located in the strait between Luzon and Mindoro islands, generated a tsunami with maximum runup of 6 meters. Numerous casualties were reported with damage to public and private structures from the earthquake and subsequent tsunami.

On Indonesia's Java Island, Mt. Merapi erupted in November with devastating results killing at least 58 people and leaving many with injuries. Eruptive activity and associated pyroclastic flows continued into December and have damaged structures and ruined potable water supplies. No tsunami activity has been reported due to the inland location of Mt. Merapi.

A very unusual, localized tsunami occurred on November 3, 1994, at Skagway, Alaska. This landslide generated tsunami killed one person.

The international tsunami community extends its sincerest sympathies to those countries, communities and local families impacted by the recent earthquake, volcanic and tsunami activity. These tragic losses have increased our overall concern and awareness to the continuing threat of natural hazards, particularly tsunamis. We recognize a country's first priority following a natural disaster is to provide relief and rehabilitation to the impacted areas, helping to mitigate any further loss of life and reestablishing essential services. Post-disaster tsunami surveys, an import aspect in verifying numerical models and helping us understand the tsunami generation process, provide important field data to the tsunami research community. By working within the ICG/ITSU framework, field surveys will be conducted with respect to local customs and practices, fully coordinated with and in support of the host government(s). In the long-term, post-disaster tsunami field surveys foster cooperation within the tsunami community by bringing together international participants with the goal of mitigating loss of life and property damage to this terrible natural disaster.

NEWS EVENTS

Great Earthquake and Tsunami of October 4, 1994

A great earthquake of Richter magnitude 8.1 (JMA, 43°22'N, 147°40'E; depth 30 km), moment magnitude of 8.2, occurred in the Pacific Ocean near the Kuril Islands, northeast of Hokkaido Island and to the east-southeast of Shikotan Island, at 13:23 UTC on October 4, 1994. Within minutes, the JMA issued a tsunami warning for the Pacific coast of Japan while Russia's Sakhalin Tsunami Center issued a tsunami warning for the Southern Kuril Islands. A damaging tsunami was generated that impacted the Pacific Ocean coastline of Hokkaido and the southern Kuril islands. Hokkaido has been hit by three major earthquakes in the last two years, beginning with an Ms 7.8 near Kushiro in the Pacific Ocean on January 15, 1993, the devastating Hokkaido Nansei-Oki earthquake of July 12, 1993 that generated a killer tsunami in the Japan Sea and most recently an even larger earthquake that generated a locally destructive tsunami in Japan and Russia.

Based on the earthquake's location and magnitude, regional tsunami warnings issued by national centers in Japan and Russia, water level reports from tide gauges, tsunami damage in the source area, and historical tsunami information, the Pacific Tsunami Warning Center (PTWC) issued initially a Pacific-wide tsunami warning at 14:33 UTC, October 4, 1994. Although no damaging tsunami waves were reported outside the local tsunami source area for the October 4 event, the tsunami was recorded by tide gauges located as far away as the United States West Coast, Tahiti, and Chile. When the Midway Island tide gauge reported a maximum wave oscillation of just over 0.5 meter, there was lingering concern of the potential for damaging wave activity in Hawaii. However, when the tsunami reached Hawaii the maximum wave height did not exceed one meter (nor did it exceed significantly one meter in other distant Pacific locations). PTWC issued a cancellation of the tsunami warning at 21:55 UTC when no *destructive* waves were recorded/reported outside of the tsunami source area.

Near the tsunami source area, the tsunami was recorded by tide gauges operated by the JMA (see figure 1). In Russia, the tide gauge at Malo-Kurilsk (inside of Molokurilskaya Bay on the *west* side of Shikotan Island) recorded a series of waves the first being 2.8 meters (double amplitude) followed by waves of 2.0 and 1.34 meters (Gusiakov, e-mail). Dr. Gusiakov also reported that the variability of tsunami runups on the east coast of Shikotan Island is very small with no little or no effect caused by the bottom bathymetry and land topography of the bays. He noted the runup distribution of this event (in the near field) is quite different than that on Okushiri Island (Japan) in July 1993.

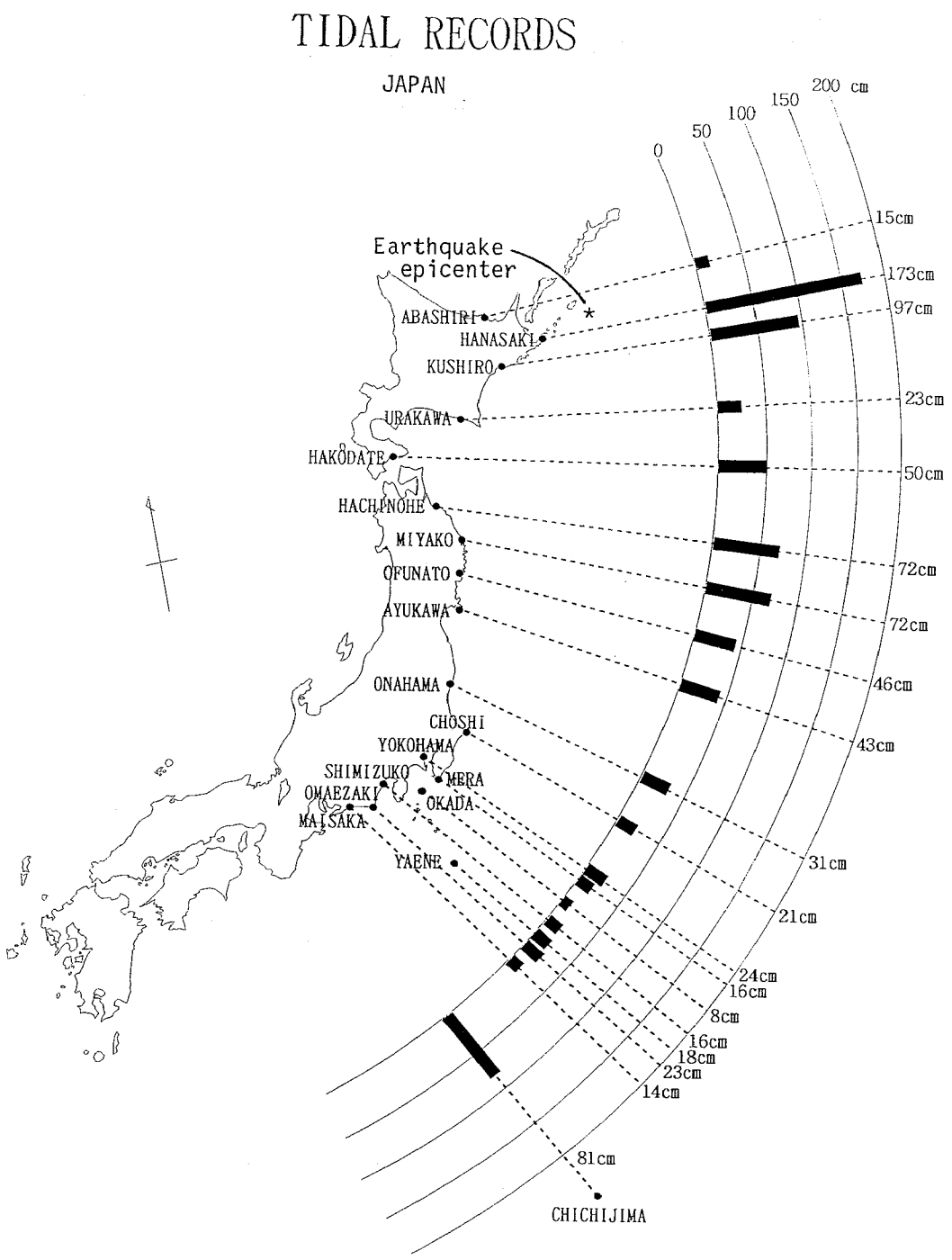
A special international field survey team visited the Kuril Islands and provided runup measurements that confirmed the locally destructive nature of the October 4 tsunami (see table 1). The Russian/international survey team, representing the Commission on Tsunami and Marine Disasters, and United States participants, representing the National Science Foundation, reported the following:

Table 1. **October 4, 1994**

Tsunami Runup Values in Russia, Tsunami of 4 October 1994
Runup values are reported in meters, corrected for tides and related coseismic subsidence; locations on Shikotan by GPS.
(data provided by Gusiakov, e-mail)

LOCATION	Lat °N	Long °E	Runup(m)
Iturup Island:			
Kasatka Bay, southern part	44.917	147.633	3.4
Kasatka Bay, northern part	45.008	147.710	3.0
Kunashir Island:			
Lovtsova Cape	44.450	146.567	2.0
Krugloe Lake	44.383	146.417	4.7
Ilyushina River	44.150	145.950	6.4
Kosmodemianskoe village	44.100	145.900	4.6
Yuzhno-Kurils village	44.033	145.767	4.7
Goryachiy Beach	44.000	145.800	4.2
Sernovodsk village	43.900	145.633	2.6
Veslovsky neck	43.733	145.567	3.1
Golovnino village	43.733	145.517	2.0
Paltusovo village	43.720	145.433	2.6
Shikotan Island:			
Kray Sveta Cape	43.831	146.905	6.00
Dimitrova Bay, northern part	43.801	146.825	8.20
Dimitrova Bay, southern part	43.793	146.824	10.40
Snezhkova Bay	43.780	146.787	8.00
Agatovay Bay	43.744	146.728	8.10
Tserkovnaya Bay, eastern part	43.743	146.712	7.25
Tserkovnaya Bay, central part	43.743	146.690	8.50
Delfin Bay, western part	43.756	146.614	3.00
Zvezdnay Bay	43.772	146.606	4.00
Gorobets Bay	43.822	146.710	3.00
Krabovaya Bay, northern part	43.833	146.730	2.60
Malo-Kurilskaya Bay	43.867	146.817	2.90
Small Kuril Islands:			
Polonsky Island	43.633	146.333	4.00
Zelyenyi Island	43.517	146.100	1.50
Baklannyi Cape	43.433	146.067	3.50
Yury Island	43.450	146.100	1.50

Figure 1. **October 4, 1994**



Tsunami of 4 October 1994 as recorded by tide gauges. Amplitudes in centimeters, provided by the Japan Meteorological Agency. Data are preliminary. Tide gauge records from the area south of Maisaka are under investigation for evidence of tsunami.

NEWS EVENTS

Intensity of the earthquake on a scale of 1-12; Shikotan Island 8-9, Kunashir Island 7-8, Iturup Island 6-7. Casualty and damage reports; 11 were killed, 32 sustained severe injuries, 210 sustained moderate to minor injuries, and 100 buildings were damaged.

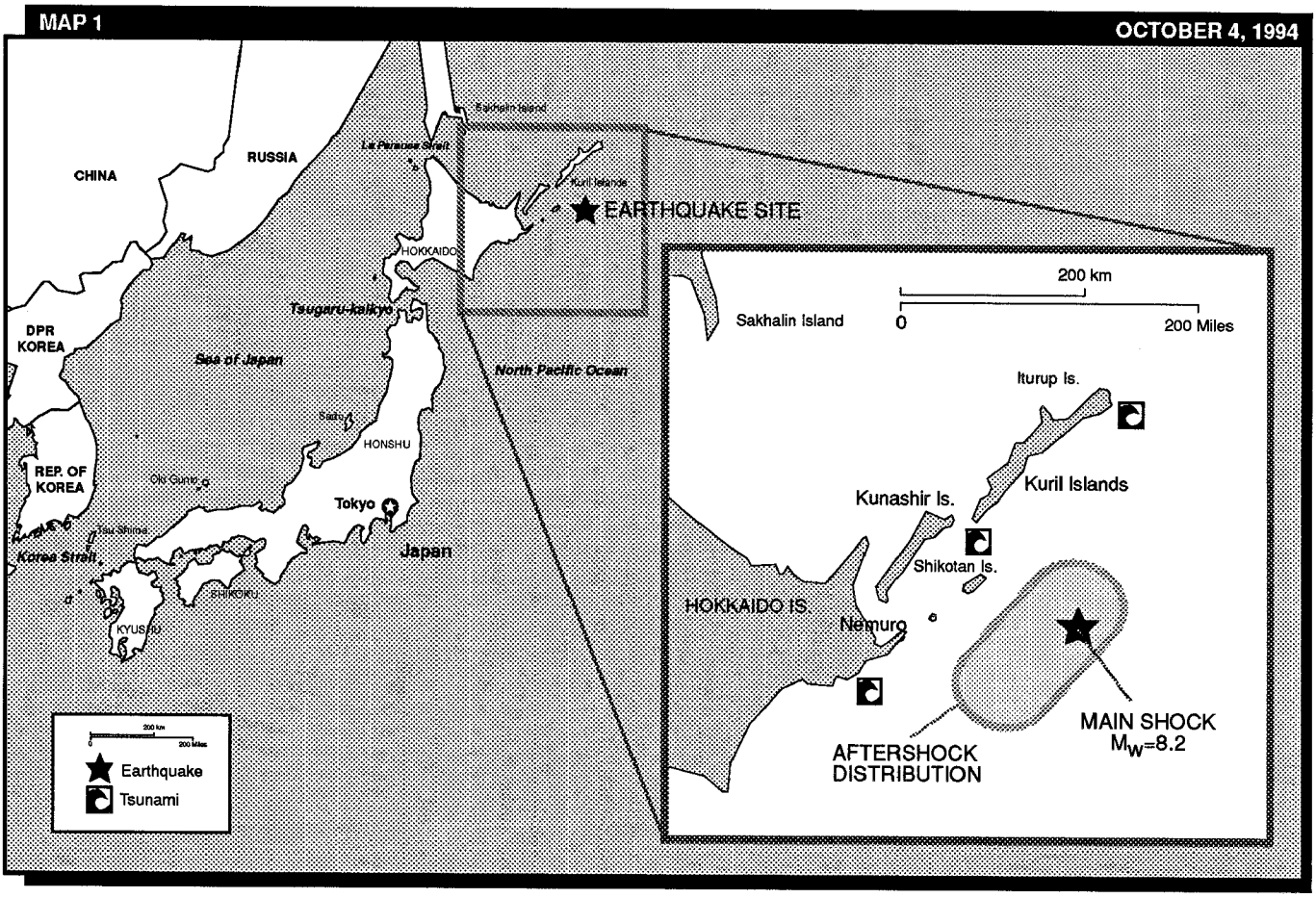
At Yuzhno-Kurilsk, Kunashir Island, tsunami heights ranged from 2.5-3 m. In the older part of the town (fronted by a gentle beach) all houses were damaged by the wave that penetrated 200-300 m. Along the river, the wave penetrated more than 500 m inshore. Two bridges were destroyed, and another was damaged while two houses were completely washed away, and another was dragged 300 m inland. All moorings were damaged. Two 300 ton fishing boats, 5 pontoons and several motorboats were thrown on dry land. One 300 ton vessel was damaged by the tsunami wave and sunk in waters 100 m deep. This earthquake and tsunami were the strongest for this region in the 20th century and are estimated as the 100 year event (B. Levin, E. Kulikov, & C. Synolakis, e-mail).

Outside the source area, the tsunami was recorded clearly by tide gauge stations in many locations. Table 2. lists maximum wave heights at selected locations, while Figure 1. displays maximum amplitudes recorded in Japan.

An interesting observation of the small tsunami waves as they approached the north shore of Oahu, near Haleiwa, was made by Mr. Arnold Hori aboard a Civil Air Patrol plane. The editor thanks Dr. George Curtis for providing this anecdotal report. (edited for length and content)

"We ended up circling the little notch shaped bay called Kaiaka Bay which is within Wailua Bay but on the southern extreme. Kaiaka is the bay that empties the Paukauila Stream (which extends to the SE) as well as the Kiikii Stream (which extends to the south and goes past the Otake Store). Near the mouth of the Paukauila Stream, but before the point where it joins the Kiikii Stream to empty into the bay, there is a spit of land. I think of this as a sand spit; however, it is actually mostly mud. This spit extends from the south side of the Paukauila to approximately two-thirds the distance across the stream channel. I estimated the above water level height of the spit as one foot; although the pilots thought that it was two to three feet. At this time the water within Kaiaka Bay and 1/4 mile seaward was very muddy (i.e., dirt colored). This was the same color as the water in both the streams.

After about two overflights of Kaiaka Bay, I observed small ripplets of waves in the bay moving towards the streams. The ripples also seemed to be creating lighter foamy areas where the



water was cream (vice dirt) colored. These are best described as 5-10 foot long trails. At this time the mud spit began getting covered by the muddy water. I am unsure of the time at this point, it may have been 11:10 am (local). As we continued to circle, the spit became awash with the water and small wavelets of water seemed to be moving upstream on Paukauila & Kiikii; however, I would not characterize this motion as a tidal bore. At this time the crew made a radio report that there was a one foot surge going up the stream (at that time we were referring to the steam as the 'Waialua River'). Then in about two more overflights the water receded and the spit again became exposed. I observed the same covering and receding of the water again during the subsequent overflights. On two occasions while circling, our aircraft went out to the offshore area to warn off a couple of boats which started heading to shore."

Table 2. October 4, 1994

Pacific-wide Tsunami Recorded

Preliminary data - as obtained by tide gauge instruments; maximum oscillation, peak to trough in meters

Location	Maximum (*meters*)
Wake Island	0.18
Midway Island	0.54
Dutch Harbor, Alaska	0.2
Nawiliwili, Kauai	0.36
Kahului, Maui	0.80
Kawaihae, Hawaii Island	0.18
Hilo, Hawaii	0.48
Pago Pago, Am. Samoa	0.15
Papeete, Tahiti	0.30
Crescent City, California	1.1
Talcahuano, Chile	0.80
Valparaiso, Chile	0.45

A strong Richter magnitude 7.2 aftershock occurred at 07:56 UTC on October 9, 1994 in the same area as the main earthquake. Preliminary reports from the JMA indicate a small tsunami was generated and recorded by tide gauges at Hanasaki (9 cm) and Kushiro (3 cm). No damage was associated with this tsunami. The JMA, Seismological and Volcanological Department, has kindly provided the International Tsunami Information Center (ITIC) with aftershock data from the October 4th earthquake; the data are available from ITIC in ASCII (tabular format) in the DOS environment. *(Unless noted otherwise, water level data and damage reports provided by respective national agencies representing the participating Member States of the International Coordination Group for the Tsunami Warning System in the Pacific)*

Obi Island, Indonesia Earthquake and Tsunami of October 8, 1994

Unrelated to the October 4 and 9 seismic and tsunami activity in the northwest Pacific, a strong Richter magnitude 6.9 earthquake shook the Halmahera Island region of Indonesia at 21:44 UTC, October 8, 1994. A bulletin issued by the Department of Humanitarian Affairs in Geneva, reports the earthquake and a *three meter tsunami* were responsible for casualties and damage to houses and public facilities to six villages on Obi Island. Although contacted by ITIC, the Indonesian ICG/ITSU national authority (the Meteorological and Geophysical Agency) has not confirmed this report.

Mindoro Island, Philippines, Earthquake and Tsunami of November 14

A strong earthquake of Richter magnitude 7.1 (moment magnitude 7.1, Harvard) occurred along the Lubang fault in the Cape Verde Island passage between Luzon and Mindoro islands during the early morning hours of November 15 (03:17 local time). With measured runups in excess of six meters, this tsunami caused significant loss of life and property damage. Information released by the Philippine National Mapping and Research Information Authority (NAMRIA) and PHIVOLCS, report that at least 74 people lost their lives (due to the tsunami/earthquake) and that numerous private and public buildings, roadways and bridges were destroyed. A 7.2 megawatt power barge that provides electricity to Mindoro Oriental province ran aground due to the tsunami disrupting service to thousands. Post-disaster field teams organized in cooperation with the Philippine government conducted surveys in the tsunami impacted areas. The reports revealed the tsunami reached the shore within as little as two to three minutes of the earthquake, leaving very little time for the coastal residents to seek high ground. Table 3 displays field runup measurements obtained by international survey teams working in collaboration with PHIVOLCS.

The NAMRIA report stated that Barangay Malaylay, a small low-lying island adjacent to the north coast of Mindoro Island, suffered the most casualties and damage from the tsunami. It reportedly has 24 dead with 4 still unaccounted for and where the tsunami reached up to 6 meters high (coconut-tree height). Both Nipa (made from palm fronds) houses and several with concrete walls and foundations were totally wiped-out by the waves (photo 1). The waves were so tremendous that pedestal foundations were uprooted, houses were dragged by several meters, and fish ponds and gates were destroyed.

At the coastal town of Baco, most affected were roads and bridges where vertical displacement was observed from 0.6 to

1 meter while horizontal movement was estimated to be between 1 to 2 meters. Bridge approaches subsided about 0.30 to 0.50 meters, while some were displaced from their abutments. Numerous big cracks can be seen on the road, splitting culverts and rendering the road totally impassable (photo 2).

At Barangay Wawa, one of the areas hit severely by the tsunami waves reportedly has six dead mostly children. Nipa houses were flattened by the waves and dragged several meters inland. In this area, concrete and masonry houses appear to have much less damage from the tsunami but with noticeable cracks from the earthquake. The temblor affected also the Barangay health center and the concrete fish landing shed.

Barangay Pambisan, also at Baco, and Malaylay reportedly had no casualties and the only effects were damaged fish pens. Noted changes in the area include the increase of free flowing well water. The presence of shallower offshore waters

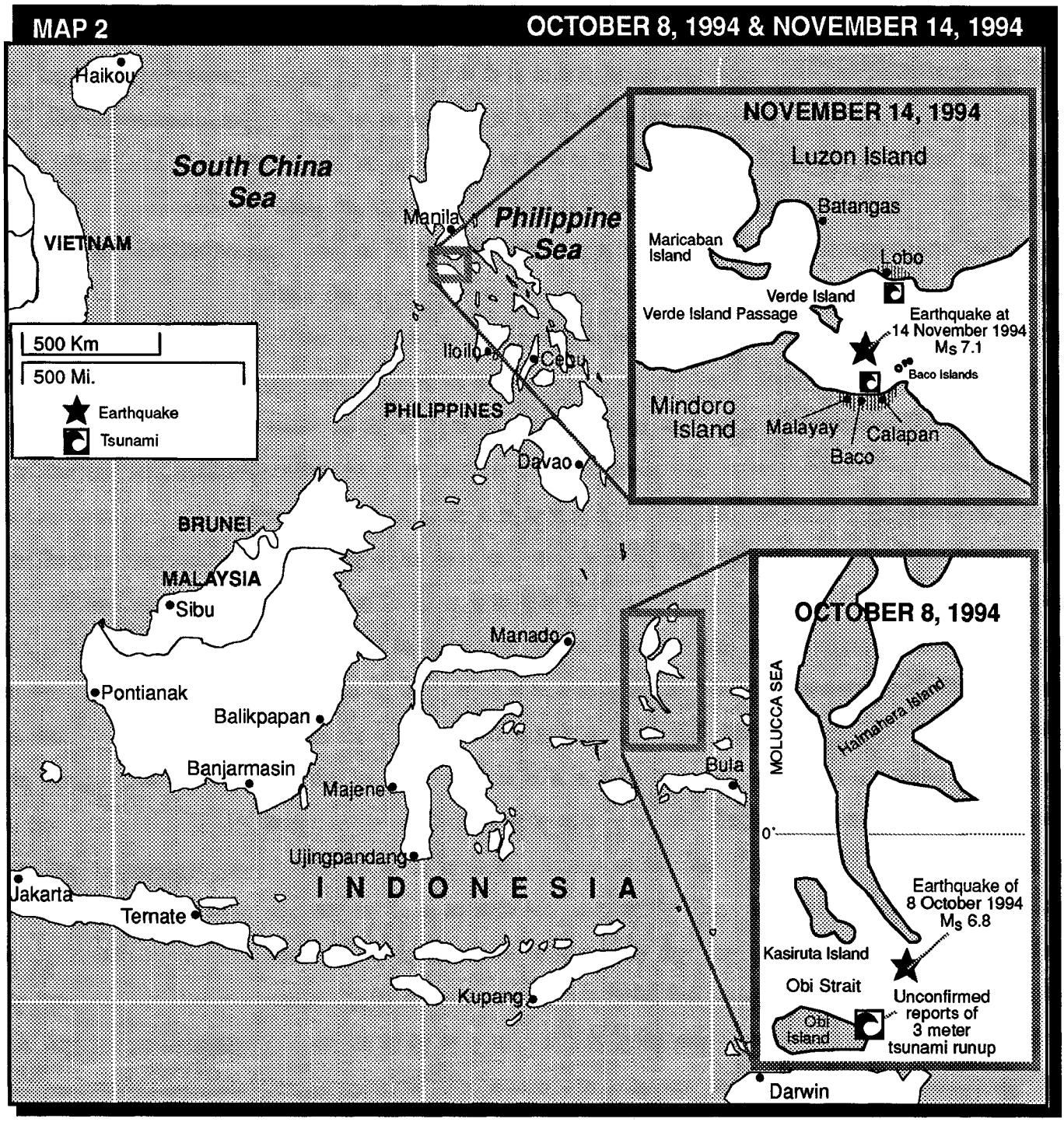


Table 3. November 14, 1994

Preliminary Report of Field Survey
Mindoro Island, Philippines Tsunami of 14 November 1994 preliminary data provided by F. Imamura and C. Synolakis
No tidal correction applied

NAME-LOCATION	LAT	LONG	RUNUP (m)
ON LUZON ISLAND:			
BARANGAY SAWANG	N13°37.656'	E121°13.545'	3.85
LAGADLA RINN	N13°37.688'	E121°12.915'	3.15
LAGADLA RIN	N13°37.705'	E121°12.810'	3.37
LOBO	N13°38.085'	E121°11.813'	2.55
LOBO	N13°38.17'	E121°11.676'	2.15
VERDE IS.	N13°33'0.03"	E121°05'40.3"	3.56
VERDE IS.	N13°13'49.6"	E121°05'29.5"	2.74
BACO IS.	N13°29'03.9"	E121°10'50.7"	NONE
BACO IS.	N13°28'28.5"	E121°09'51.6"	1.63
BACO IS.	N13°28'09.9"	E121°09'33.6"	6.1
BACO IS.	N13°28'09.9"	E121°09'33.6"	3.5
BACO IS.	N13°27'51.7"	E121°09'25.7"	6.63
BACO IS.	N13°27'51.7"	E121°09'25.7"	7.15
ON MINDORO ISLAND:			
CALAPAN	N13°25'42.5"	E121°11'40.9"	2.33
CALAPAN	N13°25'02.5"	E121°11'1.5"	2.64
CALAPAN	N13°24'53.6"	E121°10'40.7"	1.86
IBABA	N13°24.895'	E121°10.517'	1.8
BALETE	N13°24'59.5"	E121°09'36.2"	2.18
BALETE	N13°24'59.5"	E121°09'36.2"	1.9
PACHUKA	N13°24'59.5"	E121°09'36.2"	2.23
CHARICO	N13°24'36.9"	E121°09'20.9"	2.11
CHARICO	N13°24'36.4"	E121°09'07.6"	1.7
CHARICO	N13°24'36.4"	E121°09'07.6"	2.04
CHARICO	N13°24'36.4"	E121°09'07.6"	1.65
WAWA	N13°24'31.8"	E121°08'39.4"	2.39
WAWA	N13°24'28.1"	E121°08'34.8"	1.65
WAWA	N13°24'28.1"	E121°08'34.8"	2.17
WAWA	N13°24'29.3"	E121°08'33.7"	1.55
BARUYAN RIVER	N13°22.944'	E121°08.483'	0.5
WAWA	N13°23'50.9"	E121°08'27.3"	2.86
WAWA	N13°24'26.2"	E121°08'26.7"	3.98
WAWA	N13°24'26.2"	E121°08'26.7"	2.02
WAWA	N13°24'16.02"	E121°08'26.3"	1.44
BARUYAN	N13°24.377'	E121°08.268'	2.4
PAMPISAN	N13°25.594'	E121°08.246'	2.15
PAMPISAN	N13°24.633'	E121°08.215'	1.75
PAMPISAN	N13°24.606'	E121°07.969'	3.0
PAMPISAN	N13°24.697'	E121°07.873'	4.0
PAMPISAN	N13°24.736'	E121°07.714'	2.75
PAMPISAN	30m west of previous point		4.3
(NEAR) BACO	N13°24.79'	E121°07.618'	4.3
BACO	N13°24'45.1"	E121°07'28.9"	3.29
BACO	N13°24'45.1"	E121°07'28.9"	3.12
MALAYLAY	N13°25.126'	E121°05.661'	3.25
(NEAR) MALAYLAY	N13°24.5'	E121°04.516'	1.4
WAWA IS.	N13°24.836'	E121°02.894'	3.5
WAWA IS.	N13°24.8'	E121°02.815'	3.2
VILLAFLOR	N13°26.964'	E121°00.286'	2.35

apparently saved the community from the damaging tsunami waves.

Philippine President Fidel Ramos visited the tsunami-impacted area on November 17 where it was observed the affected coastal population was relocated to higher ground where evacuation centers were established. Since the coastal population is dependent on the local fishery, most houses are located near or on the water's edge. Long-term relocation of the coastal communities will be difficult as they would be removed from the source of their livelihood, fishing (from DHA report).

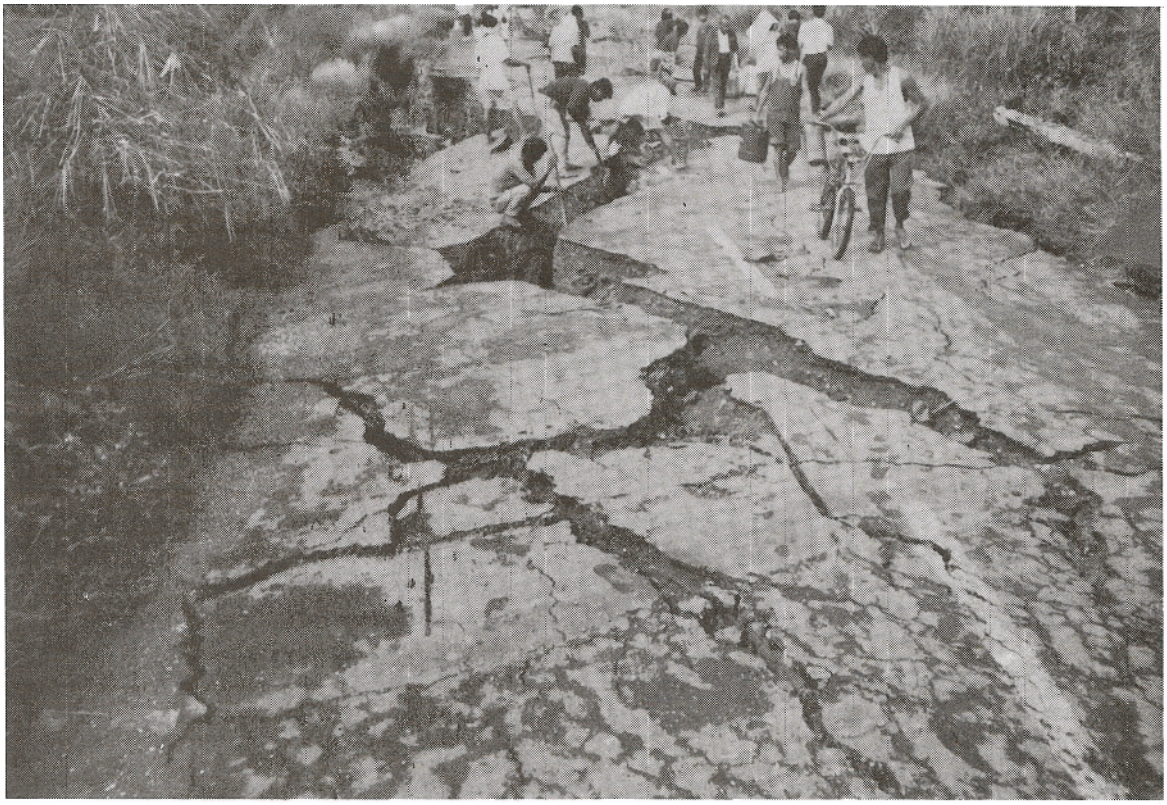
ABOVE: Where Nipa houses once stood at Barangay Malaylay, all that remains after the tsunami are remnants of the concrete footings and a few personal effects.

NAMRIA operates a tide gauge at San Jose, Occidental Mindoro, located on the opposite side of the tsunami-impacted areas of Mindoro Island. The tide gauge record from San Jose shows small tsunami wave oscillations on the order of a few centimeters. The Manila tide gauge record shows no evidence of tsunami wave activity. ITIC thanks Commodore Feir (NAMRINC&GS) and his office for providing field information and photographs on this locally destructive tsunami in the Philippines.

Nonseismic Tsunami Event in Skagway, Alaska

Jim Lander, University of Colorado, submitted the following article on a nonseismic-related tsunami in Skagway, Alaska, that claimed one life. The information for this article was gathered from a telephone conversation with the editor of the local newspaper and the event is being studied by several engineering companies.

A landslide generated tsunami occurred at Skagway, Alaska, on November 3, 1994 at about 19:00 hours (local time) which generated a 20-25 foot wave in the harbor. Workers had been working on the White Pass and Yukon Railway Dock and there was pile driving equipment and about 9,000 cubic yards of riprap weighing about 10,000 tons on the dock. There was a minus tide of3 to 4 feet (below sea level) which triggered a slide



Residents of Barangay Tulaybagin begin repair work on the severely cracked and displaced roadway.

of the glacial outwash material on which the dock was built. The slide was estimated to be 600 feet wide, 50 to 60 feet thick and 4,500 feet long containing 1-3 million cubic feet of material. The (tsunami) wave crossed the harbor and caused one fatality, Paul Wallen, on the ferry terminus dock. *This is the first tsunami fatality in the United States since 1975* (two deaths were attributed to the November 29, 1975 local tsunami on the Big Island of Hawaii) and the first in Alaska since 1964.

The Skagway tsunami event caused $1,000,000 in damage to the Ferry Terminus, and $100,000 to the small boat harbor which was between the two docks. Replacement costs for the railroad dock is estimated at $15 - 20,000,000. *ed.* It is interesting to note that "nonseismic" tsunamis may be infrequent but present a serious hazard with little if any natural warning. Accounts of nonseismic tsunamis in oceanic and inland seas have been documented previously (Lockridge, 1990 and Papadopoulos, 1993).

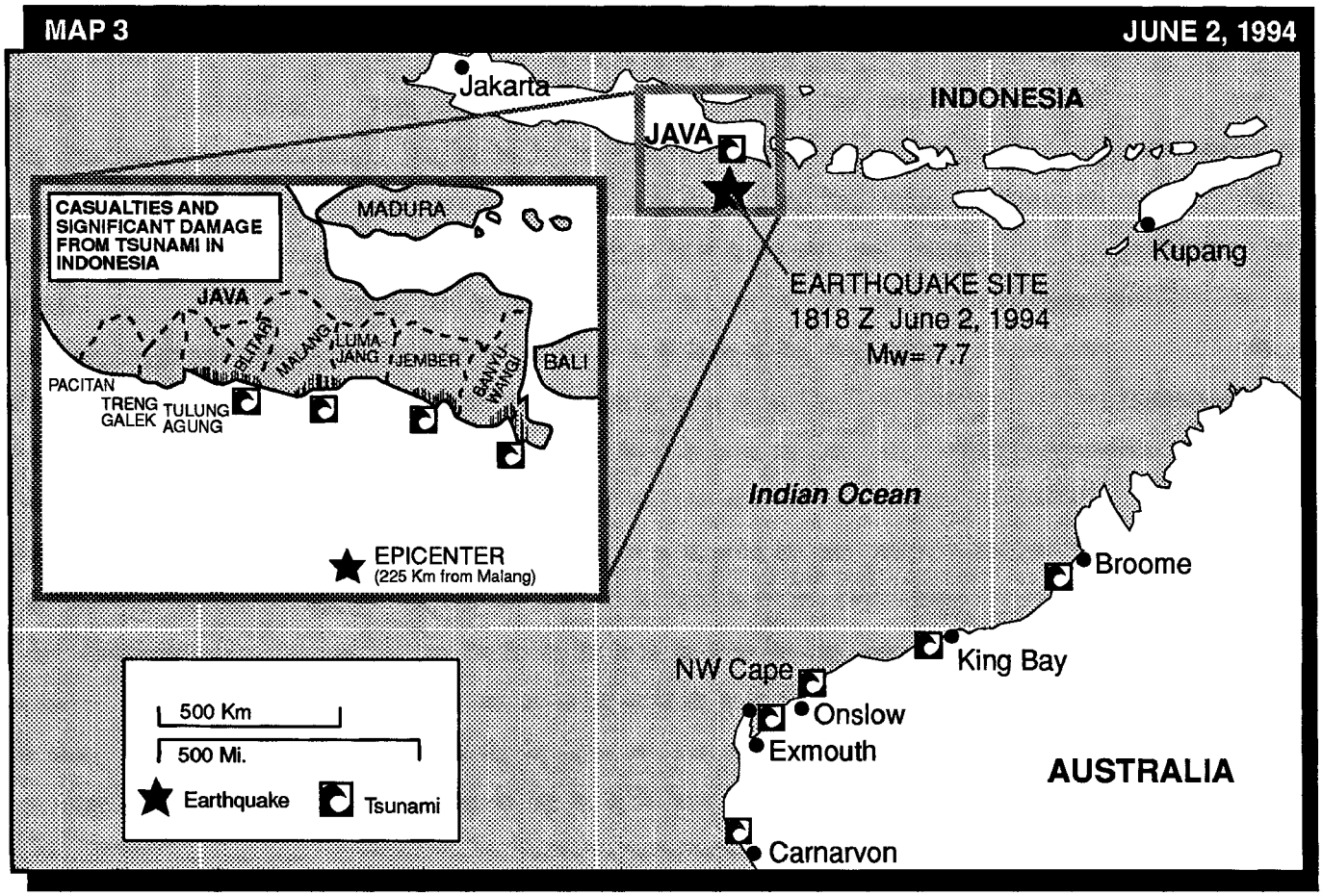
June 2, 1994 Tsunami in Australia

from Gary Foley, Bureau of Meteorology, Australia, Perth

The killer tsunami of June 3, 1994 (local time), that took over 200 lives along the Indian Ocean coastline of Java (island) Indonesia impacted the Australian coastline three to four hours later. Clear evidence of the tsunami was recorded on tide gauges at Broome, King Bay, Onslow and Carnarvon (map 3) although the actual tsunami amplitude was probably three to four times greater than observed by the tide gauges.

Several vessels operating close to shore were affected by the tsunami including a Liquid Natural Gas ship that experienced heavy loading on its mooring lines and a disrupted petroleum transfer between two vessels that caused an oil spill. The most significant impact on the shoreline occurred near the Northwest Cape. The tsunami inundated a beach and car park where the shore is exposed to a gap in the offshore reef. A surge estimated at 3 to 4 m carried hundreds of fish, as well as crayfish, rocks and coral inland for a distance of two to three hundred meters. The force of the water uprooted part of the car park's rail fence. The area was deserted at the time of inundation, however, the tsunami was heard by residents of nearby caravan parks who described the noise as like the "roar of a train." It is interesting to note there were reports of inundation in other areas further south, again where gaps in the reef exposed the shoreline to the surge of the tsunami.

This tsunami event in Australia demonstrates the vulnerability of any coastline exposed to tsunamis, whether of local or distant origin. Tsunamis happen infrequently in this area of



Australia, however, the June 3 event clearly establishes the risk to the area and need for contingency planning, including warning systems and education.

IOC/ITSU

Tsunami Modeling Technology Transfer to Mexico

by M. Ortiz and S. Farreras

Mr. Modesto Ortiz recently completed training under the auspices of The Tsunami Inundation and Modeling Exchange Project (TIME), an international cooperative effort to transfer tsunami modeling technology. Mr. Ortiz, associated with the Centro de Investigación Científica y de Educatión Superior de Ensenada (CICESE, Mexico), spent six months during 1993 at the Tohoku University of Japan working under the guidance of Dr. Nobuo Shuto. Receiving training in tsunami inundation modeling and field survey techniques (at the site of the Hokkaido Nansei-Oki tsunami), Mr. Ortiz has adapted the modeling technology to the Mexican national supercomputer. A simulation of the July 12, 1993, Hokkaido tsunami, as a test case, was then successfully accomplished.

The September 19, 1985 Michoacán tsunami, a small but recent and well documented local event with a source area off the Mexican coast, was selected to reproduce actual tsunami inundation patterns through the computer modeling. ETOPO-5 bathymetric data was interpolated to a one-minute grid length size for the model. Preliminary results show a reasonable agreement of computed runup values with the visually observed ones at the industrial port of Lázaro Cárdenas and the tourist resort of Zihuatanejo. Maximum wave heights at the shore adequately fit with those recorded by the tide gauge in Acapulco.

Additional past-tsunami cases will be simulated before proceeding to model future extreme events to produce inundation maps for civil protection purposes.

ITSU Officer's Meeting

In Preparation for ITSU-XV

A meeting of the ITSU Officers will take place in Honolulu, Hawaii, January 24-27, 1995, under the auspices of the International Tsunami Information Center. The meeting will consider the planning and agenda for the Fifteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific. France has generously offered to host ITSU-XV in Papeete, French Polynesia. The July 1995 issue of the ITIC Newsletter will contain detailed information on ITSU-XV.

List of National Contacts, Correction

The following correction to the list of ICG/ITSU National Contacts published in the December 1993 ITIC Newsletter reflects changes received at ITIC through 31 December 1994. As always, please inform ITIC whenever there are changes.

Mr. E.T. (Tom) Finnimore
Manager, Response
Ministry of Civil Defence
P.O. Box 5010
Wellington, New Zealand
Phone: 0064-4-495 6806
Fax: 0064-4-473 7369

INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION (IDNDR)

Pan Pacific Hazards '96, Vancouver, BC, Canada

Pan Pacific Hazards '96, an international conference and trade show dealing with earthquakes, *tsunamis* and volcanoes is being organized as an important Canadian contribution to the *International Decade for Natural Disaster Reduction*. The conference and trade show are expected to attract 2,000 delegates from some 30 countries at the Vancouver Trade and Convention Center from July 29 to August 2, 1996. In conference sessions, delegates will share information, experiences and ideas on ways to reduce the social, environmental and economic impacts of natural disasters. For further information contact the Conference Secretariat in Vancouver at fax: (604)822-6164.

Hazard Mitigation in Small Communities

Assuming responsibilities for disaster planning and hazard mitigation at the community level is an important element of the IDNDR strategy. The following excerpt is taken from *DISASTERS, Preparedness and Mitigation in the Americas*, October 1994.

Many people consider risk mapping a highly technical undertaking. They imagine using satellite and computerized geographical information systems to identify natural hazards and man-made hazards, forecast demographic trends, and locate at-risk infrastructure. But risk mapping is also taking place at the community level, where maps are based not on satellite data but on observations made by mothers, teachers, school children, and social and health care workers, and where the tools to draw these maps are colored pencils, not computers.

Communities act first when disaster strikes and risk mapping can be an important step in building their self-reliance and encouraging other vulnerability reducing measures that take into account not only intermittent hazards such as floods, tropical storms, earthquakes, or chemical explosions, but also daily emergencies - unemployment, unreliable water supply and sanitation, deficient nutrition, inferior housing conditions, and limited access to health care - all of which become acute in cases of natural disaster.

Communities generally follow four steps in creating risk and resource maps: drawing up a list of problems and needs as perceived by community members; making "field" visits to analyze sites that pose a risk; creating detailed maps that show both potential hazards and resources in case of an emergency; and, finally. organizing a local emergency committee to formulate an area plan and to lead efforts in solving problems.

This basic approach to hazard mitigation is a cost-effect methodology that provides opportunities for communities to begin formulating plans that can, when implemented, save lives and protect property.

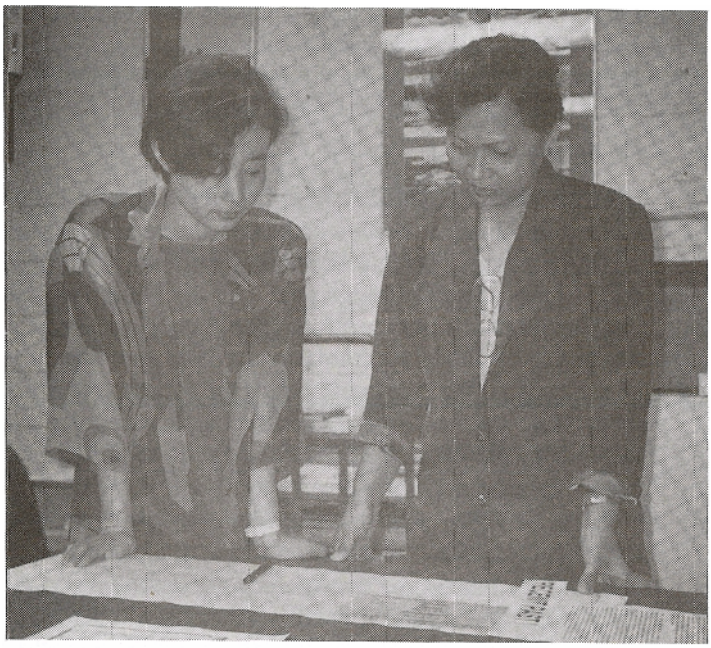
ITIC

ITIC Visiting Experts Programme for 1994

and Announcement of the 1995 *Programme*

The four-week IOC/ITIC Visiting Experts Programme concluded on December 5, 1994, with an award ceremony for the two visiting experts, Melanie Deocampo and Seung-hee Sohn. Ms. Deocampo is an Oceanographer with the Philippine National Mapping and Resource Information Authority, Coast and Geodetic Survey, in Manila. She is involved with the Philippine sea level program and responsible for monitoring the performance and data quality control of the tide gauges at Legaspi and Davao. Ms. Sohn is a Researcher in the Remote Sensing Research Laboratory of the Korea Meteorological Administration (KMA) in Seoul. With a background in seismology, Ms. Sohn is involved with automating the KMA' s national network of 12 seismic stations. Both experts were accepted for the training programme based on their involvement and interests in improving tsunami warning services in their country as well as regional area.

Receiving a briefing on PTWC's communication capabilities from Geophysicist Bruce Turner, the Visiting Experts participated in a communications test with the national dissemination points in their home countries.



Visiting experts Seung-hee Sohn (l.) and Melanie Deocampo (r.) analyzing seismic records at the Pacific Tsunami Warning Center.

Melanie and Seung-hee were exposed to a wide range of topics, issues and methodologies for developing/enhancing tsunami mitigation strategies in their countries and regional areas. A three-day field trip to the Island of Hawaii (Big Island) was conducted, surveying areas impacted by the local tsunami of November 29, 1975.

A comprehensive operations tour of the Hawaiian VolcanoObservatory was provided by Dr. Laura Kong. Hawaii State and County Civil Defense Offices provided worthwhile information on local and regional tsunami preparedness and education schemes. While at ITIC, planning was initiated for installation of a satellite data telemetry capability in Legaspi, Philippines, for sea level data.

These data will benefit not only the Philippines (they presently do not have a remote access capability at the Legaspi tide gauge), but for the Southwest Pacific regional area and for the Pacific Tsunami Warning Center as well. Working with Ms. Sohn, PTWC is transferring the technology to improve the calculation of tsunami travel times in their regional area.

Melanie Deocampo (1.) and Seung-hee Sohn (r.) receive their Certificate of Training for the 1994 IOC/ITIC Visiting Experts Programme from Acting ITIC Director, Dennis Sigrist.

ITIC

The IOC/ITIC Visiting Experts Programme is a valuable contribution to the ICG/ITSU community and fosters cooperation amongst Member States in mitigating the effects of tsunamis throughout the Pacific. The success of the program is related directly to the interest of the Member States and sponsorship by the IOC. Based on the response and support provided to this year's program, ITIC looks forward to hosting the 1995 Visiting Experts Programme.

IOC will be issuing a circular letter notifying interested scientists and experts of IOC Member States working in the field of tsunamis of the 1995 training session and procedures for nomination of qualified persons. Nominations submitted for the 1994 programme have been retained and will be reviewed for the 1995 programme. It is expected this year's session will take place during a four week period, beginning in October or November 1995.

Associate Director Position

The Acting Director, ITIC, is pleased to report that final arrangements are underway for posting of the Associate Director, ITIC, beginning in Spring 1995. Dr. M. Martinez Garcia, Director General - CICESE/Ensenada, and the government of Mexico are generously offering the secondment of Salvador Ferreras as ITIC's Associate Director for a one-year assignment in Honolulu.

As our readers might recall, it has been some time since an Associate Director has been posted at ITIC. Salvador Farreras will be joining ITIC during a time of heightened tsunami activity Pacific-wide. He will be involved in a number of ICG/ITSU activities including, but not limited to, the Southwest Pacific Regional Tsunami Warning System, an updated Master Plan for the PTWS, standardized tsunami survey procedures and automation of ITIC library resources. ITIC thanks the Government of Mexico and the support provided by the IOC for advancing the post of the Associate Director.

INTERNET Address Corrections and Additions

Takeshi Koizumi
Seismological and Volcanological Department
Japan Meteorological Agency
tkoizumi@mri-jma.go.jp

CPPT (Centre Polynesien de Prevention des Tsunamis)
Tahiti
E-mail for warnings and all operational messages
cppt@ldg.bruyeres.cea.fr

James F. Lander
CIRES, University of Colorado
jlander@ngdc.noaa.gov

ITIC Newsletter - Mailing List Update

All subscribers are reminded to update their mailing address whenever changes occur. US Postage fees increased by 10% on January 1, 1995.

Tsunami Education and Awareness Activities

The recently revised brochure on tsunami awareness, *"TSUNAMI the Great Waves"*, is receiving wide distribution to schools and educational institutions, emergency preparedness officials, industry, and the general public. Developed by ITIC in cooperation with National Weather Service Headquarters and the Alaska and Pacific Tsunami Warning Centers, the brochure was released for distribution in May 1994.

With greater emphasis being placed on tsunami hazard education as it relates to the potential for a locally generated tsunami occurring off the U.S. West Coast, the brochure is being used by educators and emergency managers. In Hawaii, a trial tsunami education program developed by ITIC and the University of Hawaii in cooperation with the Department of Education was conducted during the 1993/94 school year and was very positively received by educators and students in the local school districts on the islands of Oahu, Hawaii Maui and Kauai. *Tsunami the Great Waves* will receive a minor update and a second printing by mid-1995.

Visitors to ITIC

Mr. Takeshi Koizumi with the Japan Meteorological Agency, Seismological and Volcanological Department, visited ITIC and PTWC in early September in conjunction with a personal trip to Hawaii.

Bill Sites, Dick Hutcheon, Tom Sokolowski and Tom Ainsworth with the National Weather Service stopped by ITIC in early December while attending an internal (US) tsunami coordination meeting in Honolulu.

Jim Lander (University of Colorado, Boulder) and his wife Corinne were in Honolulu on tsunami and personal business and had the opportunity to visit ITIC.

Dr. Osamu Hiroi, University of Tokyo, and Dr. Gus Furumoto visited ITIC on December 2, to discuss the October 4, 1994 Kuril Island earthquake and tsunami. Dr. Hiroi is writing an article on the response to the tsunami event.

ITIC - On the Move, But Not Quite Yet

It has been reported in a previous issue of the ITIC Newsletter that ITIC would be changing office locations while still remaining in Honolulu. Although the move is expected, the time frame remains uncertain. Please continue to use our mailing address, telephone and fax numbers, and Internet account without change.

National and Area Reports

Earthquake/Tsunami Preparedness Drill in Peru

Gustave Bawden, Peru's ICG/ITSU National Contact, reports an earthquake and tsunami drill for the Lima/Callao area was conducted for the purpose of increasing awareness to these hazards and testing emergency response systems. Local hospitals, law enforcement, the education community and individuals participated in the July 15, 1994, exercise. Backup electrical power, communications and water service were tested as part of the drill. The positive results of the community response to the drill were very encouraging.

Enhanced Water Level Systems Record October 4, 1994 Tsunami

NOAA's National Ocean Service (NOS) is in the process of enhancing its Next Generation Water Level Measurement System for operational and post-tsunami research applications at 44 selected locations. The enhanced stations are located along the US West Coast, Alaska, Hawaii and other domestic and foreign sites in the Pacific Basin.

Thirty-one stations have been upgraded with a new data storage capability that captures five days of 15-second interval water level data (pressure transducer) on a solid state data cartridge. Additional enhancements provide for the rapid telemetry (via GOES satellite) of 1-minute water level data triggered by a tsunami detection algorithm. The 1-minute data are also stored for up to 20 days and can be accessed by a phone/modem connection. This project is a cooperative effort between NOS and the National Weather Service and would not be possible with out the dedicated support of the NOS Pacific Operations Section, NOS Headquarters staff and NWS field technicians. Dr. Frank Gonzalez with NOAA's Pacific Marine Environmental Laboratory has been instrumental in advocating the collection of more frequent data soundings to improve post-tsunami data analysis.

The October 4, 1994 Kuril Island tsunami provided an excellent opportunity to test the tsunami-enhanced water level systems. The physical retrieval of the 15-second data (on cartridges) was accomplished at 27 sites three days after the tsunami event. Data in the 1-minute format was downloaded via phone for plotting and analysis. Example water level records displaying the October 4 tsunami reveal the high quality data capabilities of the enhanced systems.

1994 Kamchatka Paleotsunami Expedition

INVESTIGATION OF GEOLOGICAL TRACES OF THE 1923 TSUNAMI IN UST'-KAMCHATKA PLAIN by V.Gusiakov, K.Minoura

In July of 1994, the international team of representatives from Novosibirsk Computing Center (V.Gusiakov), Institute of Geology and Paleontology of Tohoku University (K.Minoura) and Kamchatka Institute of Volcanology (A.Vikulin, T.Pinegina) investigated the site of the April 14, 1923, tsunami which flooded with 8-meter waves a vast low-lying plain area near the mouth of the Kamchatka river. A thin (2-3 cm) sand sheet, deposited everywhere on the plain at the depth of 10-15 cm within the soil and peat thickness, was first discovered during the 1993 Kamchatka field trip and was later identified as a tsunami deposited layer.

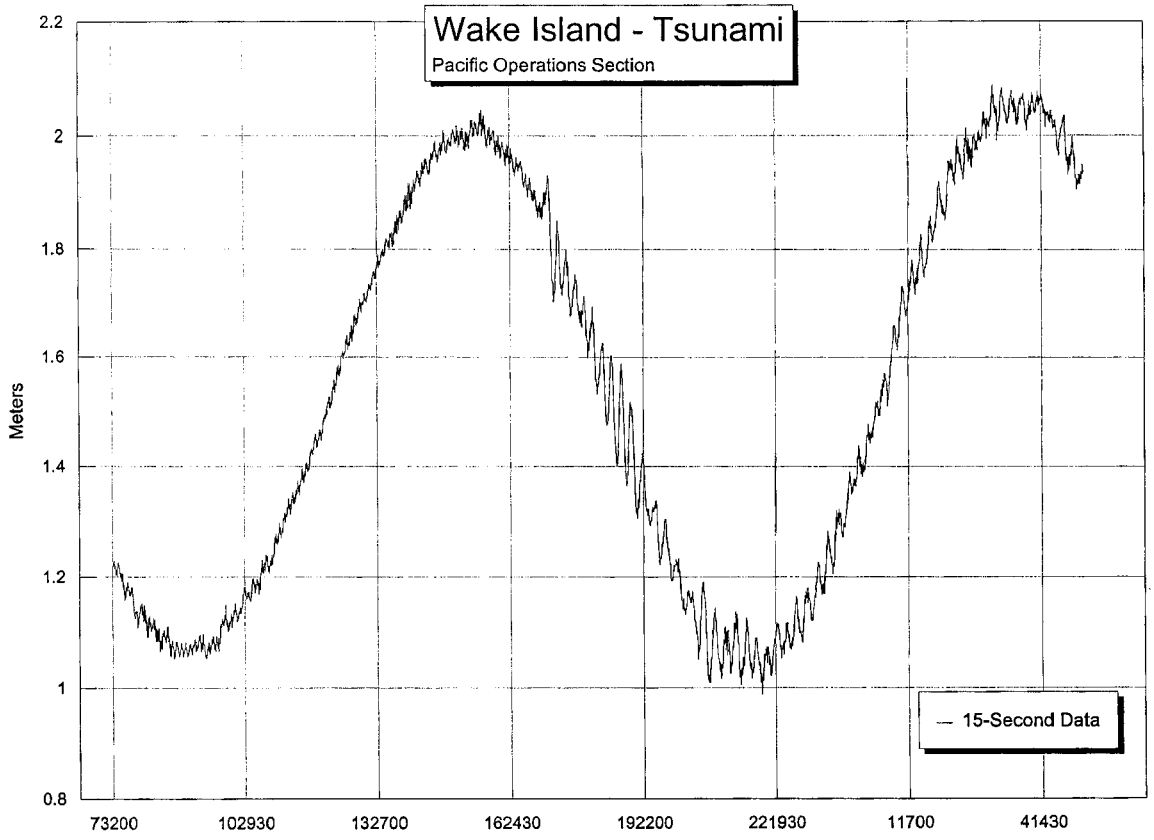
The grain-size analysis of the sand fraction of this layer showed an unusual bi-modal type of particle size distribution with a coarser peak corresponding to the traction component of the tsunami transport and a finer peak corresponding to its suspension component. Generally, tsunami deposits show a single mode distribution lacking the traction component which initially exists in coastal marine sand, but it is quickly trapped during the wave propagation by the rough surface fortified with vegetation. The unusual type of the particle size spectrum is interpreted as a result of tsunami run-up over the smooth plain area covered at the time of flooding (April 14) with a thick layer of consolidated snow and ice.

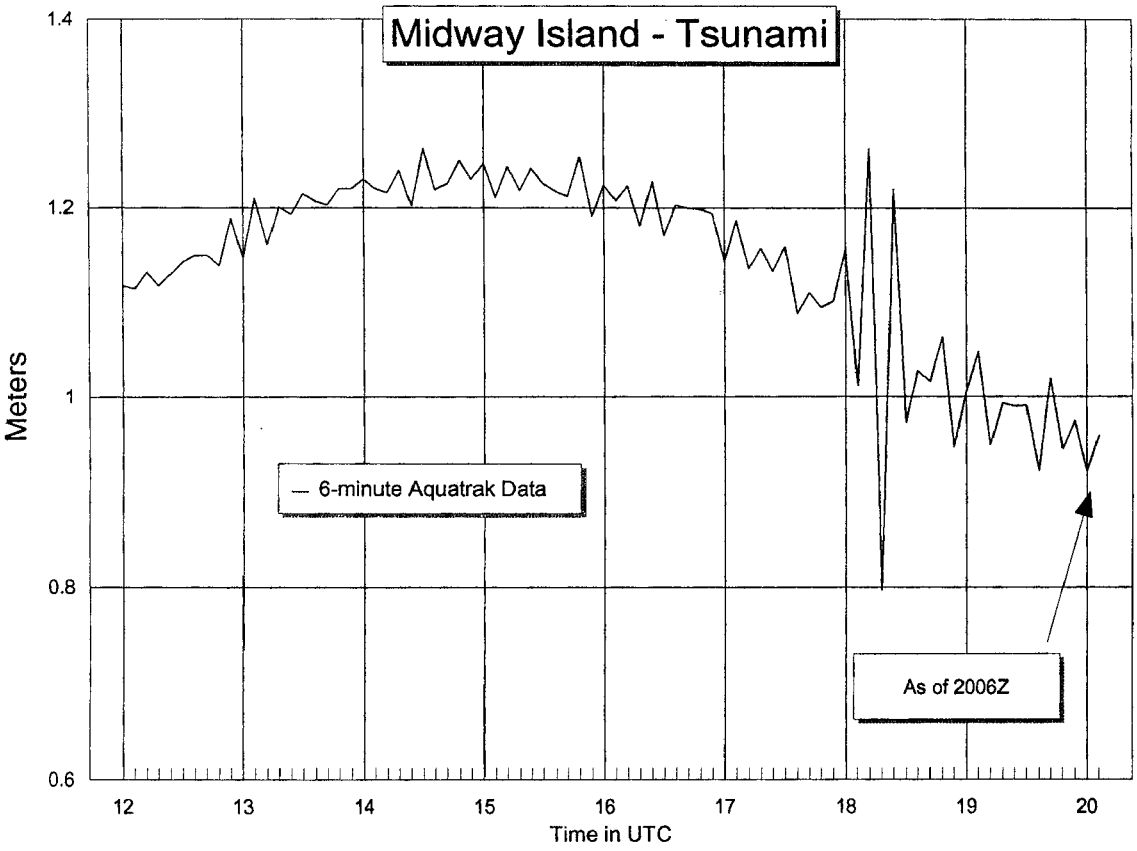
Objectives of the 1994 field work were to investigate the sedimentation process of winter-condition tsunami flooding and to trace the ultimate inland edge of a tsunami layer. We have made several cross sections over the plain up to the distance of 2500 m from the coastline taking samples at every 30 meters and could find the inland spreading of a tsunami layer roughly corresponding to the available historical evidence for the tsunami flooding. The particle size analysis of collected samples, carried out at the Tohoku University, showed distinctly landward fining sedimentation with loosing of a traction component proportional to the degree of the surface irregularity and the level of vegetation.

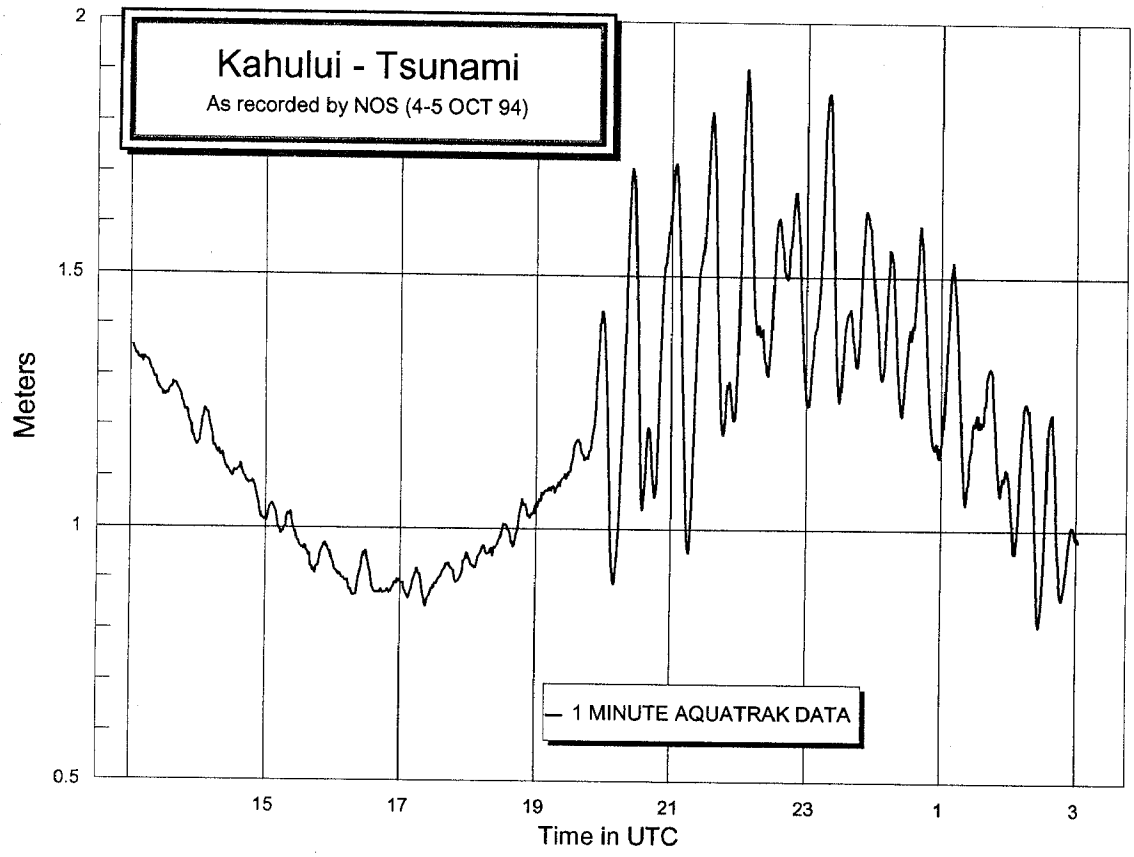
In summer 1995, the field paleotsunami investigations are planned to be continued on the northeast coast of Kamchatka, where historical earthquake and tsunami records are almost absent.

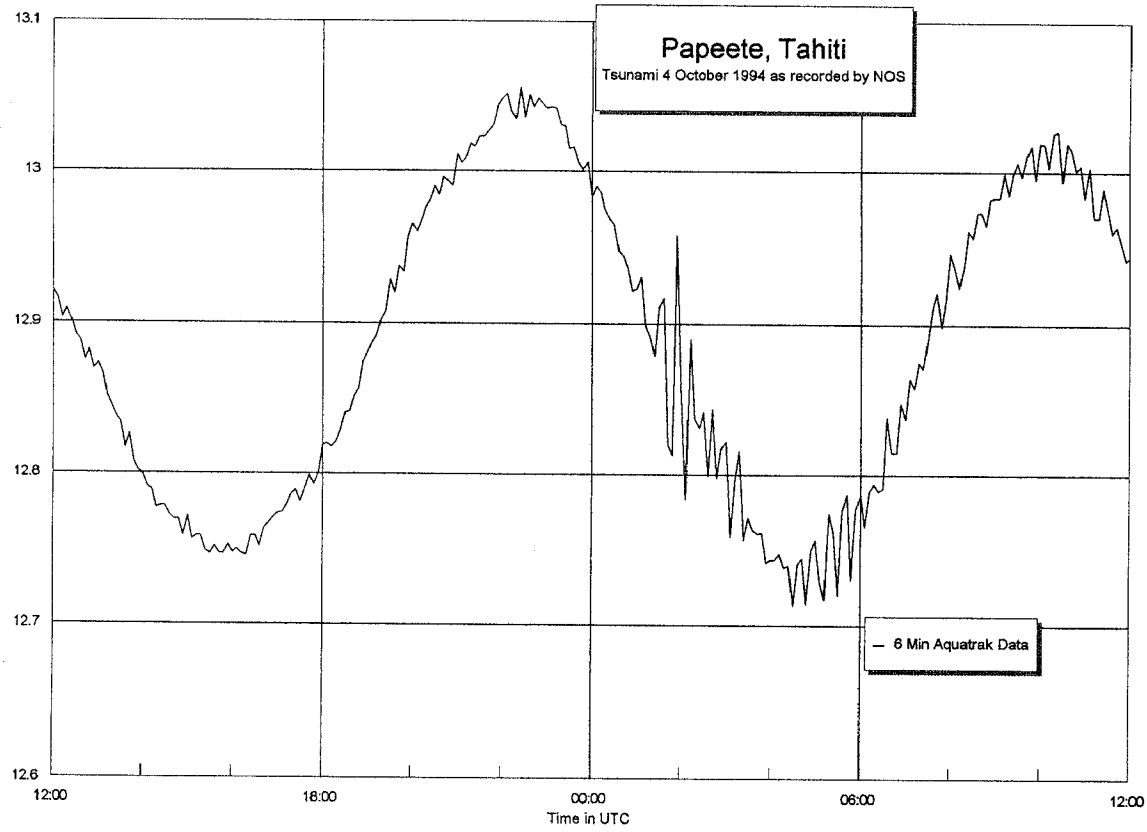
Hilo Tsunami Museum

Plans are underway to establish a tsunami museum in Hilo, Hawaii, that will pay tribute to victims of past tsunamis and provide an educational emphasis for visitors and local residents alike. University of Hawaii tsunami researchers George Curtis, Walt Dudley and Dan Walker along with Dennis Sigrist, ITIC's Acting Director, are on the museum's scientific advisory board. According to Dr. Dudley, "The need for tsunami education is greater now than ever, and we feel the museum is a very good way of addressing that (need)." The opening of the museum, to be located in the downtown area of Hilo, will coincide with the 50th Anniversary of the terribly destructive April 1, 1946, tsunami that took many lives in Hilo. Also a UJNR (United


Wake Island - Tsunami
Pacific Operations Section
Meters
2.2
2
1.8
1.6
1.4
1.2
1
0.8
73200
102930
132700
162430
192200
221930
11700
41430
15-Second Data


Midway Island - Tsunami
Meters
1.4
1.2
1
0.8
0.6
6-minute Aquatrak Data
As of 2006Z
12
13
14
15
16
17
18
19
20
Time in UTC


Kahului - Tsunami
As recorded by NOS (4-5 OCT 94)
Meters
2
1.5
1
0.5
15
17
19
21
23
1
3
Time in UTC
1 MINUTE AQUATRAK DATA


Papeete, Tahiti
Tsunami 4 October 1994 as recorded by NOS
13.1
13
12.9
12.8
12.7
12.6
12:00
18:00
00:00
06:00
12:00
Time in UTC
6 Min Aquatrak Data

States - Japan) Symposium and other observances including a commemoration of the great Sanriku tsunami in Japan 100 years earlier are planned.

Susan Gaughan Tissot, as Acting Director, has taken a leadership role in managing the development of the museum. The Hilo Tsunami Museum is incorporated as a non-profit corporation.

Announcements

MEETING REPORTS:

European Geophysical Society, Natural Hazards Meeting, April 1994

by Stefano Tinti

At the XIX General Assembly of the European Geophysical Society (EGS) held in Grenoble, France, eight symposia were organized on Natural Hazards (NH). One of these (NH6) was devoted to tsunamis with the title "Hazardous Tsunamis: Experiments, Observations and Theoretical Modeling", held on April 26, 1994, convened by Prof. Sergei Soloviev and Stefano Tinti. The meeting was saddened by the news of the sudden death of Prof. Soloviev. In his honor the symposium was opened with a memorial speech presented by Dr. Oliounine, who stressed Soloviev's valuable contribution to the development of seismology and tsunami research as well as his unforgettable human qualities, such as his generosity, sensitivity, diligence and dedication.

The symposium consisted of three sessions respectively chaired by Bjorn Gjievik, Alastair Dawson and Gerassimos Papadopoulos. A total number of 20 papers were presented by scientists coming mostly from European countries, but also from other parts of the world (Bulgaria, France, Germany, Greece, Italy, Norway, Portugal, Russia, Turkey, United Kingdom and USA). The paper abstracts are published in "Annales Geophysicae", Supplement 1 to Volume 12, Part 1, pages C207-C212, 1994.

Western Pacific Geophysics Meeting, July 1994

The Western Pacific Geophysics Meeting; sponsored by American Geophysical Union (AGU), was held July 25-29 in Hong Kong. There were two tsunami sessions on July 28th. Ten papers were presented in a session on tsunamis in the Western Pacific region. They included a theoretical study of run-up, geological studies of tsunami deposits, seismological and hydrographical modeling studies of recent earthquake tsunamis, and a report of recent and future activities of the Pacific Tsunami Warning Center. In a session on the 1993 Hokkaido Nansei-Oki earthquake and tsunami, seven papers were presented. The abstract volume was published as a supplements to *Eos*, Transactions, AGU.

National Tsunami Workshop - Brisbane, Australia

Australia's national representative to the ICG/ITSU, Peter Noar of Australia's Bureau of Metrology, and associates Rex Falls and Jack Rynn seized an excellent opportunity to convene a Tsunami Workshop with a focus on the tsunami hazard and warning systems in Australia.

The Workshop was held in Brisbane on August 25, 1994, prior to the Tropical Cyclone Warning System Conference to maximize participation. The major objectives were to exchange ideas, knowledge and expectations of those in research with various types of operational practitioners, such as emergency managers, policy makers and meteorologists. The Workshop proceedings provide a basis for planning the evaluation of future warning system requirements recognizing the various needs and increasingly sophisticated response procedures of the user community.

Nature's Fury at the Bishop Museum, Honolulu, Hawaii

Honolulu's Bishop Museum opened its doors on September 17, 1994 to a four month exhibit depicting natural hazards in Hawaii. One of the most important sections of the exhibit suggests ways that people can prepare for and respond to natural emergencies. Bishop Museum collaborated with several community groups and agencies, including the state and local Civil Defense, the PTWC, ITIC and the National Weather Service, to present accurate and educational displays. As part of the overall theme, the exhibit displays, in part, pictures and accounts of historic tsunamis and earthquakes in Hawaii. The educational and preparedness aspects of Nature's Fury make a lasting impression that offers realistic ways to protect life and property.

Tsunami Special Session, AGU, December 7, 1994

by Frank Gonzalez

A special session at the fall AGU Meeting in San Francisco was held to discuss theoretical, numerical, and observational aspects of tsunami research and the application of this research to hazard mitigation. A full day of tsunami presentations were made on December 7th. Eleven oral presentations were made at the morning session "Tsunamis I: Tsunami Warning Systems."

The first three papers provided an overview of the existing warning system and summarized the results of three recent

workshops on tsunami hazard mitigation. This was followed by two papers on the 3 June 1994 East Java tsunami, and six papers dealing with specific technical issues related to tsunami warning systems. Fourteen posters were presented at the afternoon session "Tsunamis II: Tsunami Observations and Modeling." Four dealt with the 12 July 1993 Hokkaido Nansei-Oki tsunami, one with the 19 September 1985 Michoacan, Mexico tsunami, and the remaining eight covered a variety of interesting technical issues in observational and modeling efforts.

On Friday morning, a special session was held, entitled "The October 4, 1994, Mw 8.3 Kurile Islands Earthquake." Thirteen posters were presented, including four which dealt directly with the tsunami and its effects. An evening meeting to discuss the upcoming International Meeting on Tsunami Measurements (see related article) was well attended.

Tsunami Coordination Meeting

An internal coordination meeting to discuss the US national tsunami warning program was held in Honolulu during mid-December. The meeting brought together National Weather Service tsunami management staff as well as the geophysicists-in-charge from the Alaska and Pacific Tsunami Warning Centers. Dennis Sigrist, ITIC's Acting Director, participated during the first day of the three day meeting. A number of issues were covered with an emphasis on improving tsunami warning products and services.

Upcoming Meetings

XXI General Assembly of the IUGG, July 2-15, 1995, Boulder, Colorado,

Tsunami Symposium, July 3-4, 1995 Boulder, Colorado

17th INTERNATIONAL TSUNAMI SYMPOSIUM
DR. EDDIE N. BERNARD - Corresponding Lead Convenor
DR. NOBUO SHUTO - Co-Convenor
DR. GERASSIMOS A. PAPADOPOULOS - Co-Convenor
PROFESSOR STEFANO TINTI - Co-Convenor

The XXI General Assembly of the International Union of Geodesy and Geophysics will be held in Boulder, Colorado, from 2-15 July 1995. For this assembly, the Tsunami Symposium will be jointly hosted by the International Association for the Physical Sciences of the Oceans (IAPSO) and the International Association of Seismology and Physics of the Earth's Interior (IASPEI). The Symposium will be held on Monday and Tuesday, July 3 and 4, and will focus on research that leads to disaster reduction.

The themes of the Symposium are: 1) historical and contemporary observations of tsunamis, 2) physical processes of tsunami evolution, and 3) hazard reduction though assessment techniques and warning systems. Dr. Gerald Hebenstreit will serve as editor of the book derived from the presentations made during the Symposium. The Tsunami Commission will hold an election for new officers.

American Water Resources Association (AWRA) Symposium, Honolulu

The AWRA has announced its Summer Symposium In Honolulu, Hawaii, June 25-28, 1995. The topic of the symposium, Water Resources and Environmental Hazards: Emphasis on Hydrologic and Cultural Insight in the Pacific Rim, includes a number of technical sessions. The session on Natural Hazards and Hydrologic Consequences includes, in part, volcanoes, earthquakes and *tsunamis*. Contact AWRA at fax: (301)493-5844 for further information.

International Workshop on Tsunami Measurements

Organizer: James F. Lander
Co-organizers: Harry Yeh & Costas Synolakis

An international workshop will be held in Estes Park, Colorado, June 27-28, 1994, immediately *before* the IUGG Tsunami Symposium, to explore a wide range of questions relating to the collection, availability, standards and use of tsunami-related data. Several conditions make this a timely endeavor. Tsunamis in Nicaragua, Japan, Indonesia, and the South Kuril Islands have been destructive and triggered investigation by international teams of scientists and engineers.

The results may be useful in designing future field investigations. Changes in instrumentation including remotely accessible digital recording marigraphs and ocean bottom pressure gauges cause problems as well as offer new opportunities. Improved computer modeling capability gives the possibility of improving the accuracy of run-up and the inclusion of this information customized for each community in tsunami warnings. An evening conference during the recent AGU meeting in San Francisco discussed issues relating to the questions, problems, and scope of the workshop.

IAPSO General Assembly Meeting, August 5 - 12, 1995, Honolulu, Hawaii

The XXI General Assembly of IAPSO will be held in Honolulu at the Hilton Hawaiian Village, on the beach in Waikiki. Dr. Douglas Luther, University Of Hawaii - School of Ocean, Earth and Science and Technology, will chair the Local Organizing Committee. All abstracts for the General Assembly must be sent to the IAPSO Corresponding Lead Convenor by January 31, 1995. Several scientific group tours are planned, including a visit to the Pacific Tsunami Warning Center.

UPCOMING MEETINGS

To be on the IAPSO mailing list, send your address to:
Dr. Robert E. Stevenson, Secretary General
Box 1161, Del Mar, CA 92014-1161, USA
Fax: 619 481-6938
Internet: IAPSO@Electriciti.com

For those interested in tsunamis, the IAPSO Symposium PS-05 Program will focus on the circulations and processes in the coastal oceans, especially those having connections or interactions with the land. Problems of estuaries, studies of natural hazards in the coastal zone including storms and *tsunamis*, and presentations on the mitigation of these hazards will be included.

As some researchers may find it advantageous to attend the IAPSO Symposium in Honolulu, some papers related to tsunamis can be accommodated in a session of Symposium PS-05. In keeping with the theme of that symposium, tsunami-related papers should address effects, e.g., coastal flooding and hazards, protection, and other mitigation measures. For information on Symposium PS-05, contact:

Fred E. Camfield
Corresponding Lead Convenor
IAPSO Symposium PS-05
US Army Engineering Waterways Experiment Station
3909 Halls Ferry Road,
Vicksburg, MS 39180-6199
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International Workshop on Long-Wave Runup Models

September 12-16, 1995
at Friday Harbor, San Juan Island, Washington, USA

The objectives of the workshop are to review research progress in tsunami runup, compare numerical and analytical prediction models with laboratory experimental data using benchmark problems, and identify future research directions in terms of mitigation of tsunami hazard.

A special session will also be arranged to discuss field observations of recent tsunamis: Nicaragua, Flores, Hokkaido, Kuril and Java tsunamis. The format of this workshop stresses discussions, instead of formal presentations. Candid and constructive criticisms can lead to effective and efficient advancement of our modeling capabilities. Both international and domestic researchers who are active in tsunami research are welcome to participate.

The workshop is sponsored by a grant from the National Science Foundation of the United States and is open to all researchers around the world. Participants are expected to cover their travel costs although some funding for travel is available. Committee members for this workshop include:

Philip Liu: plliu@bridge.tn.cornell.edu
Costas Synolakis: costas@mizar.usc.edu
Harry Yeh: harryeh@u.washington.edu

Seismology and Seismic Hazard Assessment - Managua, Nicaragua

Professor Peter Bormann of Potsdam's (Germany) GeoForschungsZentrum, is coordinating an international training course focusing on seismic hazards in Managua, Nicaragua. A number of international organizations are co-sponsoring the course; the host institution in Managua is Instituto Nicaraguense de Estudios Territoriales (INTER).

A one-day session during the expanded five week-long course will discuss tsunami hazards, the ICG/ITSU and specific tsunami case studies. The training course is scheduled to take place in November 1995. Field trips to a nearby volcano, seismic station and the Pacific coast to view tsunami effects are planned.

Tsunami Society

The **Tsunami Society** and the Editor of the *Science of Tsunami Hazards* have **new addresses; please make note of the new Editorial Board.**

The Tsunami Society
P.O. Box 25218
Honolulu, Hawaii 96825, USA

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Dr. Shigehisa Nakamura, Kyoto University
Dr. Yuri Shokin, Novosibirsk
Mr. Thomas Sokolowski, Alaska Tsunami Warning Center
Dr. Costas Synolakis, University of California
Professor Stefano Tinti, University of Bolonga

The *Science of Tsunami Hazards* Volume 12, Number 2, was mailed to Society members in mid-December. Items of interest include articles on the 1992 Flores Island (Indonesia) earthquake and tsunami; Finite Element method to compute the propagation of tsunamis; Hokkaido Nansei-Oki tsunami at Korea; and tsunami of August 23, 1872. Earlier this year, The *Science of Tsunami Hazards* Volume 12, Number 1, was published and mailed. The Editor welcomes the submission of manuscripts for articles. Contact ITIC or Dr. Mader for Tsunami Society membership information.

PUBLICATIONS OF INTEREST

Publications of Interest

Expert Tsunami Data Base

As a result of a feasibility study, a concept and a prototype of the Expert Tsunami Data Base (ETDB) was developed at the Tsunami Research Group of the Novosibirsk Computing Center, Russian Academy of Sciences. The ETDB is intended to be a comprehensive source of observational data on historical tsunamis in the particular region along with some basic additional and reference information related to the tsunami problem and to provide an enhanced environment for IBM PCs and compatibles for retrieval, visualization and processing of data.

The ETDB contains in digital form all available historical earthquake and tsunami information (source parameters, observed heights, original historical descriptions, etc.) as well as basic reference information on regional seismic and mareograph networks, regional geography, geology and tectonics. Additionally, it includes some blocks for tsunami modeling (e.g. calculation of static bottom displacement, tsunami travel time charts) and some standardized built in tools for data processing and plotting. The specially developed graphic shell provides the possibility to manipulate maps, models and data in a convenient and efficient manner.

The ultimate goal of the ETDB Project is to develop the comprehensive regional databases on tsunami and related geophysical phenomena, which contain the complete set of original, uninterpreted information available to anyone who wishes to revise estimates, to make individual interpretations, to raise questions or to propose improvements. The final product could be used not only as a historical tsunami database, but also as a convenient electronic textbook and reference book on the tsunami topic as well as a computer aided device for investigation of different aspects of the tsunami problem.

As a pilot project, the ETDB has been developed for the Kuril-Kamchatka region. Currently, it contains the condensed source data of almost 45,000 events occurring within the region from 1737 to 1990 and extended data on 129 tsunamigenic events (among them 115 having regional and 14 distant sources). The tsunami data set are cross referenced to the earthquake database and consists of four main blocks: detailed source data of tsunamigenic events, coastal observations of tsunami wave heights, original descriptions of tsunami manifestation (in Russian) and bibliographical references.

The ETDB software can be customized to any other region of the Pacific and elsewhere (mainly, by extension of the geographical database) after that the actual data compiling from the existing regional earthquake and tsunami catalogs can be made in a relatively short term. For more information on the ETDB software, please, contact V.K.Gusiakov, fax: (7)(3832)32-42-59, or email: slava@comcen.nsk.su

Tsunamis In Guam

As reported in the December 1993 ITIC Tsunami Newsletter, the August 8, 1993, magnitude 8.1 earthquake near Guam caused not only earthquake damage on the island but a tsunami that was recorded as far away as the Hawaiian Islands. The Newsletter article gave a local account from a fisherman at Pago Bay whose truck was pulled out to sea by the tsunami waves.

Ms. Judy Flores of Agana, Guam, as part of a student paper, developed a very interesting report on the August 8th earthquake and subsequent tsunami. She conducted a survey of local residents on the island capturing their experiences during and following the earthquake. Some of the personal accounts report the ocean was in a very disturbed state as soon as the earthquake subsided. One account reported the ocean as "angry, the sea bubbling and foaming, swirling as if the sand was swirling up from the ocean bottom," while another account said "the currents were all zigzagged and waves were splashing in all directions." In another case, the water level in Inarajan Bay was observed by several people to have subsided immediately after the quake. An eyewitness account said it "looked like the parting of the Red Sea" as he could see the bottom of the bay. Ms. Flores' analysis of these personal accounts document the unusual wave activity observed during and following this severe earthquake.

The editor thanks Ms. Flores for her interest in documenting this first-hand information and Jim Lander, University of Colorado, for providing her report. Jim Lander (and, possibly, Ms. Flores as co-author) would like to investigate the tsunami history of Guam, particularly the series of earthquakes and subsequent tsunami on January 25, 1849 and similarities with the 1993 event.

Tsunami Shadow of October 4, 1994

Dr. Dan Walker, University of Hawaii, is actively investigating the visual appearance of a tsunami (wave) in deep water as a "shadow" or band of reduced reflectivity. This shadow effect has been observed in Hawaii for a remote source-area tsunami generated by the October 4, 1994, earthquake in the Kuril Islands. Actual evidence of the tsunami shadow is provided by an amateur video recording made by an observer on Oahu Island's north shore at Punaluu.

The shadow first appears on the horizon and extends across the entire field of view of the camera. As the shadow progresses shoreward, the area behind the band to the horizon brightens. The shadow finally disappeared when it reached the shallow reef less than 1 km from the coastline. Dr. Walker estimates the wave height in *deep water* for this particular tsunami, where the shadow effect is observed, may only be a few centimeters. The October 4 tsunami was observed as a small wave near Haleiwa as it approached the shoreline and on tide gauge records in Hawaii but with an amplitude of 40 cm. or less (see related articles).

TSUNAMI WARNING CENTER REPORTS

Tsunami Bibliography

Tsunamis on the Pacific Coast of Washington State and Adjacent Areas - An Annotated Bibliography and Directory, 1994, 18 pages, free. Copies available from Connie J. Manson, Washington State Division of Geology and Earth Resources.

fax: (206)902-1785; Internet: cjmanson@u.washington.edu

Tsunami Warning Center Reports

Real-time Tsunami Runup Gauges

submitted by M. Blackford, PTWC (see July '94 Newsletter for related article)

From their inception, the Pacific and Alaska Tsunami Warning Centers have relied on water level measuring devices that are designed to characterize tides for confirmation of the presence of a tsunami following a potentially tsunamigenic earthquake. Post-event surveys of tsunami runup usually indicate that actual flooding levels achieved by the tsunami are much higher than those observed on the tide gauges. This is most likely due to a mismatch between the response of the tide gauges and the characteristics of the tsunami waves. From the viewpoint of the warning centers, the presence of substantial water on land beyond the normal limits reached by stormy seas at the higher high tides following the predicted arrival time of a tsunami in the area would constitute firm evidence of the presence of a significant (destructive) tsunami. What is needed is a device that can detect and measure this water presence, or tsunami runup, and transmit that information to the warning centers in at least near-real time so the warning centers can use the information in their warning procedures.

Currently a number of relatively simple devices for measuring tsunami runup are being installed on several of the Hawaiian islands in areas where inundation has occurred in past tsunamis or where modeling has indicated inundation can occur (see related article in July 1994 ITIC Newsletter). These devices consist of a vertically-mounted tube containing equally-spaced catchment cups that will catch and hold water flooding the tube from the bottom. In its present form this device is of no use to the warning centers because there is no provision for transmitting the water level data to the centers in a timely fashion.

This type of device could be modified, however, to include a set of equally-spaced triggers that generate a signal capable of being transmitted back to the centers. Triggers could be purely electromechanical, such as a float closing a switch, or a combination of chemical and electromechanical properties, such as an absorbent that expands sufficiently in the presence of water to be able to close a switch, or purely chemical such as a simple cell that generates a voltage when sea water floods its electrodes. Triggers need not be limited to these suggestions but they should be relatively simple, reliable devices that function in relatively harsh salt air environments of coastal regions. The trigger outputs should be able to interface with signal conditioning equipment used to telemeter information over typical land circuits or via satellite telemetry.

These runup gauges could have a broader application in the area of storm surge runup, particularly in hurricane-prone regions. Since these devices would be located on normally dry ground, they would not be subjected to the harsh sea water environment encountered by the tide gauges. Also, these runup gauges could be incorporated into a telephone pole mounted climate/weather data monitor system, if such a system is located in a tsunami inundation zone.

PTWC Honolulu Correction

PTWC event no. 94-07, February 12, 1994, Ms 7.2 in the Vanuatu Islands, prompted the issuance of a Tsunami Information Bulletin. There was no Tsunami Information Bulletin associated with the previous event, no. 94-06 in the Marquesas Fracture Zone.

Legaspi (Philippines) Tide Gauge, Satellite Telemetry Enhancement

Planning is underway to install a satellite telemetry capability on the Legaspi tide gauge. Working with the Philippine Coast & Geodetic Survey Department (NAMRIA), this telemetry capability will greatly enhance timely communication of water level data from Legaspi. Commodore R. Feir, Director of the C&GS, has been instrumental in providing technical coordination for the installation of the telemetry equipment and Data Collection Platform (DCP). Since the DCP will use the GMS satellite for data relay, ITIC and PTWC are coordinating those details with the Japan Meteorological Agency. PTWC technical staff will work hand-in-hand with Philippine C&GS counterparts during installation of the equipment, planned for spring 1995. This international cooperative effort exemplifies the continuing success of the ICG/ITSU with the goal of mitigating the effects of tsunamis, whether on a local, regional or Pacific-wide scale.

TSUNAMI WARNING CENTER REPORTS

Summary of Pacific Basin Earthquakes
with Surface Wave or Moment Magnitudes Greater than or Equal to 6.5
(data provided by PTWC, ATWC, JMA and NEIC, July 1994 through December 1994)

Event	Date	Location	Time UTC	Lat.	Long.	Depth Km.	Ms	Mw	Action	Time Issued UTC	
94-22	Jul 13	Vanuatu Islands	0236Z	16.6S	167.5E	33	7.4	7.1			
94-23	Jul 13	Banda Sea	1145Z	07.5S	127.9E	185	-	6.5			
94-24	Jul 21	Southeast Coast of Russia	1837Z	42.3N	132.9E	473	6.8	7.2	PTWC/TIB	1936Z	
94-25	Jul 24	Vanuatu Islands	1756Z	17.0S	167.6E	33	6.5	6.6			
94-26	Aug 14	East of Kuril Islands	0131Z	44.7N	150.0E	33	6.0	6.5			
94-27	Aug 18	East of Kuril Islands	0443Z	44.7N	150.2E	33	6.5	6.6	PTWC/TIB	0528Z	
94-28	Aug 19	Santiago del Estero Argentina	1003Z	26.7S	63.4W	565	-	6.5			
94-29	Aug 28	East of Kuril Islands	1837Z	44.7N	150.2E	14	6.5	6.6	PTWC/TIB	1923Z	
94-30	Sep 1	Off Coast of N. California	1516Z	40.4N	125.6W	10	6.8	7.1	ATWC/TIB	1528Z	
94-31	Sep 16	Taiwan Region	0620Z	22.5N	118.7E	12	6.7	6.8	PTWC/TIB	0724Z	
94-32	Oct 1	Vanuatu Islands	1635Z	17.8S	167.6E	33	6.5	6.5			
94-33	Oct 4	Kuril Islands	1323Z	43.7N	147.3E	33	8.1	8.2	Local & Pacific Warnings		
94-34	Oct 8	Halmahera Indonesia	2144Z	01.2S	128.0E	31	6.8	6.9	PTWC/TIB	2232Z	
94-35	Oct 9	Kuril Islands	0756Z	43.9N	147.9E	23	7.0	7.1	PTWC/TIB	0834Z	
94-36	Oct 12	Luzon Philippine Islands	0644Z	13.7N	124.5E	33	6.1	6.9			
94-37	Oct 13	Halmahera Indonesia	0504Z	01.2S	127.9E	33	6.4	6.5			
94-38	Nov 5	Macquarie Islands Region	0216Z	57.2S	157.7E	10	6.1	6.6			
94-39	Nov 14	Mindoro Philippine Islands	1916Z	13.5N	121.1E	33	7.1	7.0	PTWC/TIB	2030Z	
94-40	Nov 15	Java Sea	2018Z	05.6S	110.2E	559	-	6.5			
94-41	Nov 20	Irian Jaya Region Indonesia	1659Z	02.0S	135.9E	24	6.3	6.6			
94-42	Dec 28	North Honshu Japan	1219Z	39.9N	144.4E	33	7.4	-	PTWC/TIB	1311Z	

TIB - Tsunami Information Bulletin

Centre Polynesien de Prevention des Tsunamis (CPPT) Tahiti

report provided by F. Schindele

A visit to CPPT was made by Hugo Gorziglia,with Chile's Hydrographic and Oceanographic Service (as well as Chairman of the ICG/ITSU). He was shown the recently installed CPPT instrumentation, Papeete (PPT) seismic vault and overview of French Polynesia seismicity. Discussions included the TREMORS system, software, installation and a planning session. It was also reported by Francois Schindele that CPPT implemented TREMORS in two other stations located on Rangiroa Atoll (Tuamotu Archipelago) and in Tubuai (Australes Islands).

ATWC Palmer, Alaska

ATWC has received a broadband seismic instrument. Data from the broadband system will enhance ATWC's capabilities by providing additional earthquake source information for determining tsunami potential. The seismometer, software and interface equipment are being thoroughly tested prior to installation.


HAPPY
NEW
YEAR